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ABSTRACT

A total of 60 students in teacher training enrolled in a Principles of Teaching Methods course participated in this study. The course consisted of four-hour weekly sessions, in which the students attended two-hour lecture sessions and taught eight to ten micro-lessons. In the microteaching laboratory, the student-teachers were arranged into groups of six to eight students. All lessons were videotaped; and immediately following the lesson, the student, supervisor and peers viewed the tape. The tapes were critically discussed, and alternative courses of action were outlined for the next lesson. The computer analysis of the data provided a diagnostic card for each student and served as a basis for laboratory supervision. Results are given. Since all the students achieved similar levels of performance towards the end of the treatment, it is concluded that the treatment is effective for student-teachers with low-entry behavior as well as for those who begin the training program with some teaching experience. (CK)

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MODIFICATION OF TEACHING BEHAVIOR THROUGH THE COMBINED USE OF MICROTEACHING TECHNIQUES WITH THE TECHNION DIAGNOSTIC SYSTEM TDS

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MODIFICATION OF TEACHING BEHAVIOR THROUGH THE COMBINED USE OF MICROTEACHING TECHNIQUES WITH THE TECHNION DIAGNOSTIC SYSTEM TDS.

DEVELOPMENT OF A SYSTEMATIC OBSERVATION INSTRUMENT FOR CLASSROOM INTERACTION

Facet Design and Analysis

The Technion Diagnostic System TDS

THE STUDY

Setting, Subjects and Procedures

RESULTS AND DISCUSSION

1. The Change in Teaching Behavior as a Result of Microteaching Treatment and TDS Feedback.
2. The Extent of Linear Relationships Between the Student's Performance in Different Lessons.
3. Effectiveness of the Treatment on the Different Sub-Groups of Student-Teachers.

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One of the most important components of the basic microteaching model in teacher education is the feedback obtained from supervisors, learners, peers and from technical aids such as audio and video recordings (Allen and Ryan, 1969). The feedback serves a dual purpose: first it provides the trainee with information regarding his behavior enabling him to design behavioral changes; and secondly, it facilitates the process of self-confrontation by triggering a cognitive dissonance which stimulates the psychological climate conducive to change (Festinger, 1957; Nielsen, 1962; Kagan, 1967; Geerstma and Mackie, 1969 and Onder, 1970).

The use of video recordings in microteaching training provides instant and accurate feedback of verbal and non-verbal classroom interaction. However, an intuitive subjective analysis of the video recording performed by a supervisor, peer or the student-teacher himself, faces the danger of being diffused and distorted by individual biases.

The combined use of microteaching with systematic observation instruments for analyzing classroom interaction has been recommended by researchers and practitioners alike (Amidon and Rosenshine, 1968 and Minnis, 1968). Both Allen, who played a major role in the development of microteaching (Allen and Ryan, 1969), and Flanders, who developed one of the most common interaction analysis systems (Flanders, 1970), recommend the combination of their systems as an effective procedure in teacher education. The researcher and practitioner in this area are faced with the question of either using one of the existing instruments or constructing a new one.

DEVELOPMENT OF A SYSTEMATIC OBSERVATION INSTRUMENT FOR CLASSROOM INTERACTION

Many instruments for systematic observation of classroom interaction have been developed thus far. Ninety-six such instruments have been published in Mirrors for Behavior (Simon and Boyer, 1967-1970). However, most of them are limited in their diagnostic capability and lacking in their conceptual integration. Biddle (1967) who reviewed many of these instruments concluded: "The majority of research workers have developed their own conceptual systems in apparent ignorance or disregard of the concepts used by other investigators and have failed to provide an analysis or theory about their underlying conceptual structure." This description reflects the general

situation of current research in teaching and touches upon one of the major conceptual problems facing research in teaching which is that of classification and dimensionalization (Medley, 1967; and Gage, 1969). The problem of dimensionalization involves finding ways to compare different classroom behaviors along basic underlying dimensions so that the similarities and the differences between them can be more clearly identified. Gage[1] (1969) distinguished between the logical and the empirical approaches to this problem. An example of a logical approach in defining the dimension of classroom discourse is the analysis of teaching into "technical skills" (Bush, 1966; Allen and Ryan, 1969) A second example is the anthology of classroom observation instruments (Simon and Boyer, 1967-1970), in which the editors classified the systems according to several criteria, such as affective, cognitive, work process, behavioral events, verbal and non-verbal behavior, teacher, students, etc.

The general empirical approach is based on the use of factor analysis: the behaviors of a large sample of teachers are measured on many variables, such as those specified by Flanders (1964, 1967), Smith (1967), Bellack et al (1966), Spaulding (1965), Medley and Mitzell (1959) and others. The intercorrelation of the scores on the variables are subjected to factor analysis. The resulting factors define the dimensions in relatively parsimonious terms.

Category systems are one way of discovering the basic dimensions of teaching. A vast pool of teaching behaviors is insufficient and of little benefit to anyone, therefore, categories can give meaning to whole blocks of behaviors, reducing them to groupings of manageable units. But category systems are inadequate for multiple educational purposes if the behaviors are classified to overlapping categories. Because of the imprecise language, they fail to reflect accurately the various areas of behavior. To be able to define the dimensions of teaching, categories of teacher behavior must be, as Gage pointed out, "mutually exclusive and yet reasonably exhaustive of the domain of significant teacher behaviors" (Gage, 1969). Thus Gage sees the facet design and analysis developed by Guttman (1954), promoted by Foa (1965) and adopted by Openshaw and Cyphert (1966); Biddle (1967); Snow (1968); Gephart (1969); Elizur (1970);

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(1) The following discussion draws heavily on Gage's analysis of the problem in his discussions of research on teaching methods in the Encyclopedia on Educational Research and the reader is advised to refer to that source for a more detailed and elaborate discussion.

Tuckman (1970); Morrison (1972) [2], and Bar-On and Periberg (1973) as a "promising approach" to the problems of systematizing and dimensionalizing classroom behavior. The systematic observation system developed in this study is based on facet design and analysis. It is our assumption that it will facilitate a better understanding of instructional processes and contribute toward the development of a formal theory of instructional process.

Facet Design and Analysis. [3]

The facet approach is a combination of the logical and empirical approaches. Beyond formalizing and organizing the definition of variables so that they do not overlap and are exhaustive of a defined domain, facet design and analysis can suggest empirically testable hypotheses about relationships between variables. The nonmetric series of computer programs: multidimensional scalogram analysis MSA and the smallest space analysis SSA developed by Guttman and Lingoes (Guttman, 1968), are providing the means for checking the correspondence between the logical structure hypothesized and the empirical structure.

The use of facets is not new, and anyone who tabulates data uses facets unknowingly. The facet approach is the application of mathematical thinking, particularly set theory, to other sciences, such as the social sciences. A set is defined as a collection of well defined objects: the objects comprising the set are known as the elements of the set. It may be specified by listing all its members, as for example, set A,

$$A = \{\text{lecturing, asking, instructing}\},$$

or by a rule which enables one to ascertain whether a particular object is a member of a set or not:

$$A = \{a \mid a \text{ is an activity of the teacher during a lesson}\}.$$

The symbol | is read as "such that".

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(2) A summary of the works cited here is to be found in Morrison's unpublished doctoral dissertation.

(3) Professors N.L. Gage and L. Guttman have contributed most valuable remarks to our discussion of Facet Design and Analysis. A more elaborate article on this subject is to be found in "The Facet Approach in Developing a Theory of Instruction" by Ehud Bar-On and Arye Perlberg (submitted for publication).

In the same way that a set may be defined as a collection of objects, one type of set may be defined as consisting of pairs of objects. This new set is known as the Cartesian [4] products of A and B. The term "product" was suggested since the total number of possible pairs, also called permutations, is the product of the number of members of set A and the number of members of set B.

For example: suppose that set A includes two elements : A={ a_1- teacher, a_2 - pupil}, and that set B also includes two elements : B={ b_1 - initiates, b_2- responds} . The Cartesian product will give the set AB={a_1b_1- teacher initiates, a_1b_2 - teacher responds, a_2b_1 - pupil initiates, a_2b_2 - pupil responds}; this set will be called the Cartesian set. In the same way the product of any number of sets may be established, thus obtaining the Cartesian set which is the collection of the permutations of these sets.

According to Guttman (1954), any set playing the role of a component set of a Cartesian set (e.g. set A or set B of the above example) will be known as a facet of that set. We see that a facet is a role filled by a set in being one of the component sets of a Cartesian set. The use of facets enables us to define the sets of variables or concepts used in an investigation in terms of sets of more basic concepts.

The first step towards formulation of a theory is formalization by data mapping. The simplest mapping method is the mapping of a set of observations into suitable categories according to classification rules.

Suppose we can specify the inter element order of each facet. That is, suppose the facets can be ordered - from a certain viewpoint - from low to high. Such ordering will be a step towards theory formulation. Specifying the order creates a partially-ordered space which permits the analysis termed partial order scalogram (POSA) by Guttman.

The Technion Diagnostic System TDS

The Technion Diagnostic System TDS is a systematic observation instrumet designed to analyze classroom interaction. It is used in diagnosing micro-teaching lessons and in research evaluating instructional processes. At present, it consists of twenty facets which have been organized into the following mapping sentence (The capitals symbolize the various facets with component elements of each facet following).

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(4) The concept of a set of ordered pairs was first proposed by the mathematician and philosopher Descartes.

Mapping Sentence for Microteaching Training Sessions (no. 1)

The change in A{verbal / non-verbal} behavior of a teacher in training (x) who is engaged in

B{lecturing / giving directions / asking questions / relating to pupil response / relating to pupil initiative} for C{classroom management / imparting knowledge / developing analytical thinking / developing creative thinking} purposes, using

the D{standard / diagnostic} training methods in giving E{short / long} lessons, to F{small / large} numbers of

G{pupil / peer} learners, while training in H{a specific / several / a whole set of} skills; when there is the

presentations of the performance of I{trainee / another person} to improve J{skill / self understanding}

according to K{imitative / analytical} principles in supervised L{group / individual} situations in the

M{presence / absence} of N{supervisor / passive group / participating group} when behavior is O{actually / desirably} demonstrated,

P{ordinary / dramatic} and Q{present / absent} re-enactments yields R{slight / great} change at S{slow / rapid}

rate end of T{short / lasting} duration.

Condensed this sentence reads: the behavioral change ABC of teacher in training (x) as a result of training method DEFGH and supervisory method IJKLMNOPQ → change RST.

In the study described herein we have focused both treatment and research only on the first three facets. In these facets we referred only to the teacher's behavior. Nonetheless, it was possible to infer pupil responses and initiatives from it. Teacher behavior was classified according to three criteria: communication language, communication method and communication level.

The facets are:

1. Facet A:	communication language	a_1 - verbal
		a_2 - non-verbal
2. Facet B:	communication method	b_1 - lecturing
		b_2 - giving directions
		b_3 - asking questions
		b_4 - responds to pupil reaction
		b_5 - responds to pupil initiative
3. Facet C:	communication level (purpose of communication)	c_1 - classroom management
		c_2 - imparting knowledge
		c_3 - developing analytical thinking
		c_4 - developing creative thinking

For each facet the order is based on the same dimension, namely increase in pupil participation: the less the teacher speaks and the more the pupils speak. The transition in the second facet is from a "lecturing" teacher, via one who "gives directions" and "asks questions", to a teacher who responds to the pupils' initiatives and reactions. In the third facet, the transition is from a knowledge level, where the emphasis is on sources of knowledge -- teacher and textbook -- to analytical thinking; where the pupil is more active, and thence to creative thinking, where most of the ideas come from the pupils. To clarify and define each element of the second facet, an additional facet analysis was necessary. The problem was to define the teacher's activities, e.g. "lecturing", without reference to "verbality" or "non-verbality" and in such a way that each of the five elements receives another permutation or "structuple" according to Guttman. The new facets found were:

Facet α : This facet was composed of three of the four possible permutations of two dichotomous teaching classification criteria: whether the teacher does or does not solicit self-expression on the part of the pupil, and whether he does or does not dictate a particular form of pupil response. The three strucuples comprising the elements of facet A were:

α_1 - does not solicit

α_2 - solicits and dictates

α_3 - solicits and does not dictate

The fourth combination was, of course, impossible since if the teacher does not solicit a response he cannot dictate its form. The three elements or "structs" as referred to by Guttman are ordered from teacher behavior that does not induce pupil participation (a_1) to that which induces participation without dictating the form of the response (a_3).

Facet β : This facet classifies the teacher's mode of teaching according to the type of activity expected from the pupil: response to the teacher's question or his own initiative. The elements of facet B were:

β_1 - response

β_2 - initiative

Here the order of the above two elements was also based on the rule that elements with higher subscripts indicate a higher level of pupil participation.

Facet γ : This facet classifies the teacher's type of activity by the criterion of whether he does or does not respond to the pupil's actions. The elements of the facet will be:

γ_1 - does not respond

γ_2 - responds

Again the elements are ordered according to increasing pupil participation, from non-response of the teacher to pupil reactions to inducing pupil participation by responding to pupil actions.

The three facets give 3 x 2 x 2, i.e., twelve structuples. Of these twelve we chose the five we considered most important, namely:

$\alpha_1\beta_{1,2}\gamma_1$ - does not solicit either reaction or initiative, and does not respond to either -- "lecturing".

$\alpha_2\beta_1\gamma_1$ - solicits a reaction and dictates its form, but does not respond -- "giving instructions".

$\alpha_3\beta_1\gamma_1$ - solicits a reaction, does not dictate its form, and does not respond -- "asking questions".

$\alpha_3\beta_1\gamma_2$ - solicits a reaction, does not dictate its form, and responds to it -- "responding to pupil reaction".

$\alpha_3\beta_2\gamma_2$ - solicits initiative, does not dictate its form, and responds to it -- "responding to pupil initiative".

The other structuples are also significant, e.g., $\alpha_1\beta_2\gamma_2$. In this type of communication the teacher does not solicit listener initiative, but when it is present the teacher responds to it. An example would be the response of a teacher to a pupil's interjection. This structuple was not included since it is infrequent. Other structuples that occur infrequently were not included in this research instrument in order not to overcomplicate it although they are important from a teacher training point of view. One such structuple is $\alpha_3\beta_2\gamma_1$, wherein a teacher solicits pupil initiative, but does not respond to it. This behavior is similar to "asking questions", but here the teacher solicits questions and ideas rather than answers.

As previously stated, the facets that define the categories, according to which the lesson time-units are allocated, are ordered from a teacher-centered to a pupil-centered style. In other words, they are ordered according to increasing responsibility of the pupil in the process. The mapping sentence for this observation is:

Mapping Sentence for Technion Diagnostic System (No. 2)

The student-teacher (x) teaches $\{a_1$ - verbally; a_2 - nonverbally$\}$ by $\{b_1$ - lecturing; b_2 - giving instructions; b_3 - asking questions; b_4 - responding to pupil reaction; b_5 - responding to pupil initiative$\}$

for the purpose of $\{c_1$ - imparting knowledge[5]; c_2 - inducing analytical thinking; c_3 - inducing creative thinking$\}$ $\rightarrow$ $\{0$ to $100\}$ frequency of 3-second time units.

THE STUDY

Setting, Subjects and Procedures.

The Technion, Israel Institute of Technology is the country's leading engineering school. The Teacher Training Department trains prospective science and engineering teachers and its graduates are awarded a B.Sc.Ed. degree. The Department also provides a program of pedagogical training for students in the science and engineering faculties who, upon completion of their studies, receive a teaching certificate.

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(5) The classroom management behavior (c_1 in Mapping Sentence No. 1) was excluded here since observation has shown that this type of behavior almost never appears in a microteaching laboratory.

Sixty students from the Teacher Training Department enrolled in a Principles of Teaching Methods' course participated in this study. The course consisted of four-hour weekly sessions, in which the students attended two-hour lecture sessions, participated in exercises for two hours, and taught eight to ten micro-lessons. The micro-lessons, lasting seven to ten minutes, were taught in a microteaching laboratory to classes consisting of five paid high school students or, in some cases, to peers. In the microteaching laboratory the student-teachers were arranged into groups of six to eight students. All lessons were videotaped and immediately following the lesson, the student, supervisor and peers viewed the tape. The tapes were critically discussed and alternative courses of action were outlined for the next lesson.

During the first lesson, which was considered a pre-test, the student-teachers received no specific instructions concerning teaching style and strategy to be employed. Analysis of the pre-test revealed that most lessons taught were of an expository nature. It was thereupon decided that the three consecutive lessons during the first semester would be devoted to the acquisition of questioning skills.

The mapping sentence (no. 2), TDS and the way it was to be used during the training was explained to the students at the beginning of the second semester. The first, fourth and last lessons given by each student during the second semester were analyzed according to the TDS. Three independent raters examined five-minute segments of the videotaped lessons and categorized the instructional process every three seconds (a total of 100 observations). Each lesson was evaluated and categorized twice; once according to the Cartesian product of facets AB (ten categories), and the second time according to facet C (three categories).

From the above thirteen categories, four combined scores were computed:

1) analytical thinking $\{c_2\}$
2) non-verbal activities $\{a_2b_1 + a_2b_2 + a_2b_3 + a_2b_4 + a_2b_5\}$
3) not lecturing $\{100 - (a_1b_1 + a_2b_1)\}$
4) relating to pupil response and initiative $\{a_1b_4 + a_1b_5 + a_2b_4 + a_2b_5\}$

The computer analysis of the data provided a diagnostic card for each student and served as a basis for laboratory supervision. The diagnostic card included the thirteen scores and the four combined scores mentioned above. Each session, the supervisor received the diagnostic cards of the students participating in their group. The supervisors' discussion was focused on specific behaviors which appeared to be deficient according to the diagnostic card. The students were advised to focus on these behaviors in the re-teach lesson.

The analysis of data presented in this paper will focus on three main topics:

1) The extent and area of change in teacher behavior as a result of the micro-teaching treatment combined with the use of TDS feedback.

2) The extent of linear relationships between the student's performance in the different lessons.

3) The differential effect of the treatment on experimental sub-groups, such as students majoring in science education; student-teachers majoring in science and engineering; students with some previous teaching experience; and students without previous teaching experience.

RESULTS AND DISCUSSION

1. Correspondence Between the Definitional System and the Empirical Structure.

In order to check the correspondence between the theoretical structure that was expected and the empirical structure, a matrix of correlation between all the frequent variables was calculated. The values of the variable were the frequencies of occurrence and the n was the different lessons given by different student-teachers. Eight structuples were frequent enough and therefore were chosen for the analysis. They are listed in Table III.

According to Guttman a theory is an hypothesis of a correspondence between the definitional system for a set of observations and the empirical structure of those observations together with a rationale for the hypothesis. (6) The expected structure which results from the specification of order within the three facets which are all ordered in the same sense of stimulation of pupil participation, is as follows:

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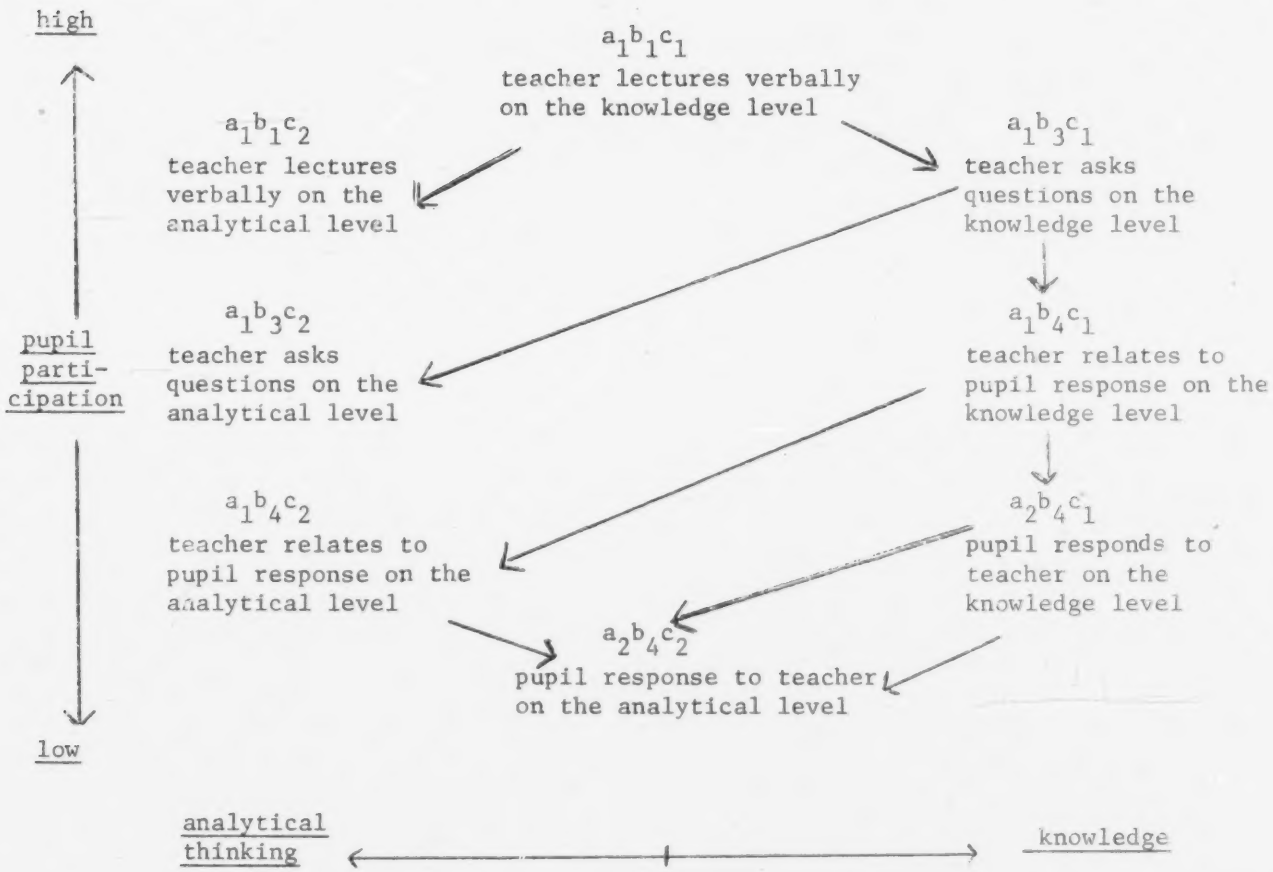
(6) For detailed explanation, see Bar-On and Perlberg (1973)



The empirical structure which will be shown in figure I results from the analysis of the 8 x 8 correlation matrix mentioned above using the non-metric computer program SSA-1. This program has a graphic output of a space diagram in which the eight variables (the chosen structuples) are represented as dots in an Euclidan space. The computer program assigns ranks to every correlation coefficient in the matrix (there are $\frac{7 \times 8}{2} = 28$ such cor. coef.). Then the transition to our coordinative space is done in a way that if correlation coefficient r_{12} between variable 1 and 2 is greater than the correlation coefficient r_{34} between variables 3 and 4, the distance between the dots which represent variables 1 and 2 will be smaller than the distance between the dots which stand for variables 3 and 4 in the space diagram (for details see Guttman, 1968). The space diagram is shown in figure I.

INSERT FIGURE I

By comparing Figure I with the scheme of the expected structure, the correspondence between the expected and empirical structures becomes very clear.

2. The Change in Teaching Behavior as a Result of Microteaching Treatment and T.D.S. Feedback

Table I shows the means, standard deviation and T-test values of the differences in pre- and post-test lessons in thirteen categories.

INSERT TABLE I

The average number of questions asked by the student- teachers increased from 8% in the pre-test to 23% in the post; the relation to pupil answers in a non-verbal manner increased from 8% to 30% on the average; and the amount of lecturing during the lessons decreased from 75% to an average of 32%. The amount of analytical thinking in the lesson increased from 13% in the pre-test to 60% in the post-test and imparting knowledge decreased from 85% in the pre-test to 34% in the post-test. Thus it can be said that in the post-test there was a greater amount of learner involvement performed at a higher level of thinking than before the treatment.

The means, standard deviation and t scores in the pre- and post-test lessons of the four combined scores in the thirteen categories are shown in Table II. From here on the analysis will focus only on the combined scores.

INSERT TABLE II

From Table II it can be seen that the differences are highly significant. The standard deviations are relatively large both in the pre-test and post-test for all combined scores. In order to examine the distribution of each score around its mean, we devided the domain of the scores (which was between 0 - 100) into nine groups; an arranged the data accordingly.

Figures II,III, IV and V present the distribution for each combined score.

INSERT FIGURES II,III, IV AND V

Before the training, seventy-one percent of the students used non-verbal communication less than 15% during the lesson; and 50% of the students lectured during more than 15% of the lesson. Ninety-eight percent of the students showed analytical thinking during less than 25% of the lesson. Because the concentration in low categories is high, and the distribution around the mean is small, it is clear that the large standard deviation resulted from the high scores of a few students who at the onset of the training deviated from the mean.

In the post-test there is no longer a concentration in the low scores as was the case prior to treatment. Over 50% of the students scored higher than 35% of each of the four combined scores. The high standard deviation, shown in table II, for the post-test is a direct result of the dispersion. It should be noted that the post-test graphs of all the combined scores, except the one for "non-verbal", show a bimodal distribution and might imply that the population should have been divided into more uniformed subgroups.

It appears that in the pre-test the student-teachers rarely called for pupil participation in the lesson and the percentage of analytical thinking was low. As a result of the treatment, the situation improved. The lessons became more learner-centered and were also conducted at a higher cognitive level. Figure VI schematically presents the means of the combined scores over all four lessons.

INSERT FIGURE VI

From this figure, it appears that the scores in the third lesson were higher than those in the post-test. Two hypotheses are presented to account for the lower scores in the post-test lesson.

a) Up to and including the third lesson, the students examined their diagnostic cards with the supervisor, and with his help decided what type of behavior was advisable to adopt in order to change their lesson into a more learner-centered one. For the post-test the students were asked to give a general lesson and make use of all the behaviors they had acquired during the year. It appears that this task proved to be more difficult to perform than the regular micro-lesson, which focused on a single behavior.

b) The videotaping of the post-test was completed in one day and the high school students who acted as the pupils were strained by having to hear more than fifty consecutive lessons. Towards the end of the videotaping they were fatigued and it was difficult for them to concentrate and participate actively in the lessons. Even so, the combined score for analytical thinking continued to increase.

An analysis of each student-teacher's diagnostic card, which is based on the TDS , and consisted of 30 categories (permutations) was performed. However, only eight of the categories appeared frequently enough, hence a T test was done on these eight scores only. Table III shows the means, standard deviation and 't's of the eight scores on the pre- and post-tests.

INSERT TABLE III

Although the total amount of lecturing decreased (see Table I), there was a significant increase in the amount of lecturing done at the level of analytical thinking. The number of questions increased significantly, both at the analytical and information transmitting levels, but the increase in the analytical level was far greater. The amount of "relating verbally to pupils' responses" at the information transmitting level decreased, while at the analytical level of thinking, this category significantly increased in the post-test. The amount of non-verbal response to pupil activities rose significantly both in the analytical and informational levels of thinking, but the improvement in the analytical level was much greater.

2) The Extent of Linear Relationships Between the Student's Performance in Different Lessons

Since most performances depend upon the student's actual ability and aptitude, a linear relationship was expected between measurements made before training and measurements made after training. In order to discover this linear relationship between the student's performance in the different lessons, the four combined scores of the four lessons were correlated.

Most of the correlations were very low and statistically not significant. It appears that the skills acquired through training were not expressed equally in all the lessons. Despite the low correlations, we calculated the regression coefficients of the post-test on the pre-test scores. The t values of the two subscores, "non-verbal" and "relates to", were significant at the $\alpha = 0.05$ level, but when we calculated the confidence intervals for these two estimates, we found that in both cases the lower limit was zero. Therefore, in this case, the assumption of a linear relationship between the pre- and post-test might not be true.

Since no linear relationship was found in the group as a whole and since the figures for the post-test (see figures I,II, III and IV) showed that the population was not a uniformed one, it was decided to divide the group into four sub-groups and look for the linear relationship in each sub-group.

It was reasonable to assume that at the start of the treatment those who had previous experience would have an advantage over those without experience. Therefore, one criterion for the division was experience. Another criterion was the status of the students in the Teacher Training Department. About half of the students participating in the study were studying for a degree in the Teacher Training Department (T.T.D.). The other half were students from other departments who were taking the course as part of the requirement for a Teacher Diploma (T.D.). In previous analyses of Technion students, it was found that students from the science and engineering faculties who are studying for a Teacher's Diploma obtained higher grades in their entrance examinations than the regular students in the Teacher Training Department. Thus one may assume that the formers' achievements would be superior.

The four sub-groups were as follows;

1) Regular Teacher Training students - experienced .
2) Regular Teacher Training students - inexperienced.
3) Teaching Diploma students - experienced .
4) Teaching Diploma students - inexperienced .

Again, we correlated the four-combined scores of the four lessons and computed the regression coefficients, but this time it was done for each separate sub-group. Once more, the results showed no significant linear relationships.

In general, it does not appear that we can predict the future success of a student-teacher from his pre-test. There was a significant improvement in the teaching behaviors of student-teachers (see Tables I, II and III), but since no linear relationships appeared between the pre- and post-tests (neither for the whole group, nor the different sub-groups), one can assume that the effectiveness of the treatment does not depend on the initial behavior of the student-teacher. Thus our treatment appears to be effective for all student-teachers including those who performed poorly on the pre-test.

3) Effectiveness of the Treatment on the Different Sub-Groups of Student-Teachers.

In order to find out whether the laboratory treatment was more effective for different groups, we analyzed the progress of the participating students according to their previous experience in teaching and their academic association with the Teacher Training Department. The means and standard deviations of the four combined scores for the four different groups of student-teachers for the pre- and post-tests are presented in Tables IV and V.

INSERT TABLES IV AND V

It is evident from the data that experienced student-teachers from both the Teacher Training Department and from other faculties of the Technion scored higher on the pre-test than did the inexperienced student-teachers. This difference disappeared in the post-test. In the pre-test there appears to be no difference between the students from other departments and those from the Teacher Training Department. However, the post-test indicated that students from other departments scored higher on the combined score "analytical thinking" than did the regular students from the Teacher Training Department. The ANOVAs for the pre- and post-tests are shown in Table VI.

INSERT TABLE VI

The pre-test ANOVA revealed a significant source of variance ($p < .05$) between the experienced and inexperienced student-teacher for three of the four combined scores. The ANOVAs for the post-test revealed significant differences in the level of analytical thinking between the student-teachers from the Teacher Training Department and those from other departments ($p < .05$). Students from other departments scored significantly higher in this area. This difference may be attributed to the nature of the four combined scores. Three of the combined scores are simple skills, easily learned by all student-teachers. The fourth combined score was "analytical thinking" for which the science and engineering students were better prepared.

CONCLUSIONS

In order to derive full advantage of the facet theory in analyzing the results, we would have had to calculate thirty scores (the number of possible permutations of the elements in facets AxBxC) for each student. Although logically all the permutations would have been meaningful for the type of lesson in which the training took place (a micro-lesson), only eight of these thirty scores appeared frequently enough for data analysis. This analysis, which compared the achievements in the pre-test and post-test regarding these eight sub-scores, is given in the body of the paper. It is suggested to other researchers that when constructing an instrument of evaluation they should build a Cartesian space of all possible categories and then observe and omit those which do not appear important (Bar-On, Perlberg, 1972). If a specific category is important to one's educational philosophy and does not appear frequently enough it is necessary to find an appropriate type of training that will lead to the increase of its frequency in the teacher's behavior.

In this paper the more general components of teacher behavior were analyzed. Three combined scores were selected for this study because they focused on student-centered activities, whereas the fourth combined score was selected as being indicative of the level of thinking. The scores for "non-verbal","relates to responses of pupils", and "doesn't lecture" were constructed to measure the extent of teacher success in creating active participation by the students in each lesson (by changing the lesson from teacher-centered to student-centered). The score for analytical thinking was constructed to measure achievements in raising the level of cognitive behavior.

It appears that combining microteaching as a method of training with the TDS as an observational and a diagnostic instrument which indicates the direction and extent of training brought about a significant change in behavior. This change was reflected in all four combined scores.

The increase in the scores of "non-verbal", "relates to responses", and "not lecturing" reached its peak at the end of the training and the analysis of the last lesson (the post-test) showed a decrease in these scores (see Figure V). Can we conclude from this that the training need cover only a short and limited time period, whereas additional training may lead to the undesirable result of a decrease in effective performance?

Two reasons for this decrease in performance have been noted earlier in the paper, namely, pupils' fatigue and the difference in the nature of the post-test and the other lessons. We believe this latter reason needs further expansion: Lessons taught in the microteaching laboratory at the Technion emphasize the practice of specific teaching skills. During the micro-lesson, the students devoted as little attention as possible to the content so as to assume concentration on skill performance and it was emphasized that the subject matter was of secondary importance. It must be noted that this was not easy to accomplish and from time to time the student-teachers tended to become over-involved with the subject matter.

For the post-test, students were instructed to present a general lesson rather than practicing a single skill. This may have caused the students to concentrate their attentions once again mainly on subject matter, thus hindering the student's ability to enhance learner-centered activities. Hence, the T.D.S. which measures student involvement indicated lower scores.

It should be noted that in schools there exists a situation similar to the post-test. A teacher in a school is usually required to cover a specific amount of material in forty-five minutes, and therefore he concentrates mainly on the subject matter of the lesson. The result of this emphasis on "imparting knowledge" is that the process of learning is neglected.

Since the scores of the post-test proved to be much higher than those in the pre-test, we may conclude that although in the field there will be somewhat of a decline in the use of specific skills learned in the laboratory, the treatment remains important in the modification of the manner of teaching.

Of additional significance is the fact that we did not find a linear relationship between the scores of the pre-test and those of the post-test. Sub-dividing our sample into the four sub-groups accounted for the initial difference

between students in the pre-test and in the post-test, but did not explain the lack of linear relationship.

It is possible that individual differences (personality, intelligence, etc.), or outside differences (supervisor, pupils, etc.) that were not reflected in the division of the sub-groups, brought about a blurring of the relationship between the initial levels and the end results. However, since all the students achieved similar levels of performance towards the end of the treatment, we can conclude that the treatment is effective for student-teachers with low-entry behavior as well as for those who begin the training program with some teaching experience. In fact, since the end results were the same for all students, we can conclude that those students with lower-entry behavior gained more from the training.

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TABLE I

Means, Standard Deviation and T-test
Values of the Differences In
Pre- and Post-Test Lessons
In Thirteen Categories

	Category	pre-test		post-test		t score
		M	SD	M	SD	
Verbal	"Lectures"	71.60	24.04	29.35	19.16	* 9.75
	"Gives directions"	0.05	0.22	0.30	0.79	1.88
	"Asks questions"	7.22	6.63	20.27	8.33	* 7.56
	"Relates to an answer"	7.62	8.08	12.30	5.11	* 2.75
	"Relates to a question"	0.30	1.13	0.37	0.77	0.33
Non-verbal	"Lectures"	2.95	3.55	2.75	3.41	0.27
	"Gives directions"	0.0	0.0	0.0	0.0	0.0
	"Asks questions"	0.75	1.44	2.75	3.24	* 4.23
	"Relates to an answer"	8.15	9.98	30.05	13.33	*10.95
	"Relates to a question"	0.0	0.0	0.0	0.0	0.0
Cognitive Level	Knowledge	85.1	24.65	34.1	13.71	* 9.09
	Analytical thinking	12.7	10.73	60.4	20.63	* 9.17
	Creative thinking	0.0	0.0	0.5	0.4	0.27

* $p < 0.01$

TABLE II

Means, Standard Deviation and T-test Values
In Pre- and Post-Test Lessons of
The Four Combined Scores
In Thirteen Categories

Score	pre-test		post-test		t scores
	M	SD	M	SD	
"non-verbal"	11.97	11.66	35.90	12.36	*11.85
"not lecturing"	16.23	17.04	43.16	15.15	* 8.78
"relates to"	24.34	23.65	66.71	20.55	* 9.52
"analytical thinking"	12.70	10.73	60.40	20.63	* 9.17

* $p < 0.001$

TABLE III

Means, Standard Deviation and T-test
Values of the Eight Scores on
The Pre- and Post-Tests

	pre-test		post-test		t scores
	M	SD	M	SD	
lectures/verbally/knowledge	64.72	26.72	15.04	16.19	11.00*
lectures/verbally/analytical	5.95	9.98	13.66	13.98	2.68*
questions/verbally/knowledge	5.17	4.49	8.17	5.91	2.81*
questions/verbally/analytical	2.31	4.05	11.68	8.69	6.67*
relates to/verbally/knowledge	5.32	5.69	4.68	4.35	0.59
relates to/verbally/analytical	2.73	5.39	7.12	5.19	3.88*
relates to/non-verbally/knowledge	5.45	6.79	10.46	9.50	3.48*
relates to/non-verbally/analytical	3.32	7.35	18.90	13.67	7.37*

* $p < 0.01$

TABLE IV

Means and Standard Deviation of the Four Combined Scores for the Four Different Groups of Student-Teachers in the Pre-Test

		not lecturing	non-verbal	relates to	analytical thinking
inexperienced (T.T.D.)*	M	17.15	10.45	11.36	7.81
	SD	17.54	10.55	13.02	17.06
inexperienced (T.D.) *	M	18.67	8.92	12.80	5.00
	SD	20.37	7.35	14.97	5.84
experienced (T.D.)	M	30.24	11.66	18.92	31.00
	SD	31.14	17.10	24.56	37.63
experienced (T.T.D.)	M	39.52	18.50	26.96	29.60
	SD	19.70	12.39	15.48	35.52

* T.T.D.= Teacher Training Department; T.D. = teaching diploma.

TABLE V

Means and Standard Deviation of the Four Combined Scores for the Four Different Groups of Student-Teachers in the Post-Test

		not lecturing	non-verbal	relates to	analytical thinking
inexperienced	M	64.45	36.36	51.37	36.00
(T.T.D.)	SD	22.15	13.44	22.54	26.20
inexperienced	M	65.58	33.94	40.83	69.00
(T.D.)	SD	17.58	9.40	15.10	21.26
experienced	M	71.86	40.90	43.14	60.22
(T.D.)	SD	17.21	11.20	11.47	24.39
experienced	M	62.76	29.50	48.26	58.20
(T.T.D.)	SD	30.90	9.76	10.86	16.20

TABLE VI

ANOVAs for the Pre- and Post-Tests

	Factor	not lecturing	non-verbal	relates to	analytical thinking
Pre-Test	experienced/ inexperienced	5.53 *	1.69	4.515 *	9.561 *
	T.T.D.-T.D.	0.036	0.679	0.040	0.68
Post-Test	experienced/ inexperienced	4.189	0.45	2.05	1.319
	T.T.D.-T.D.	0.156	0.17	0.115	7.006 *

* $p < 0.05$

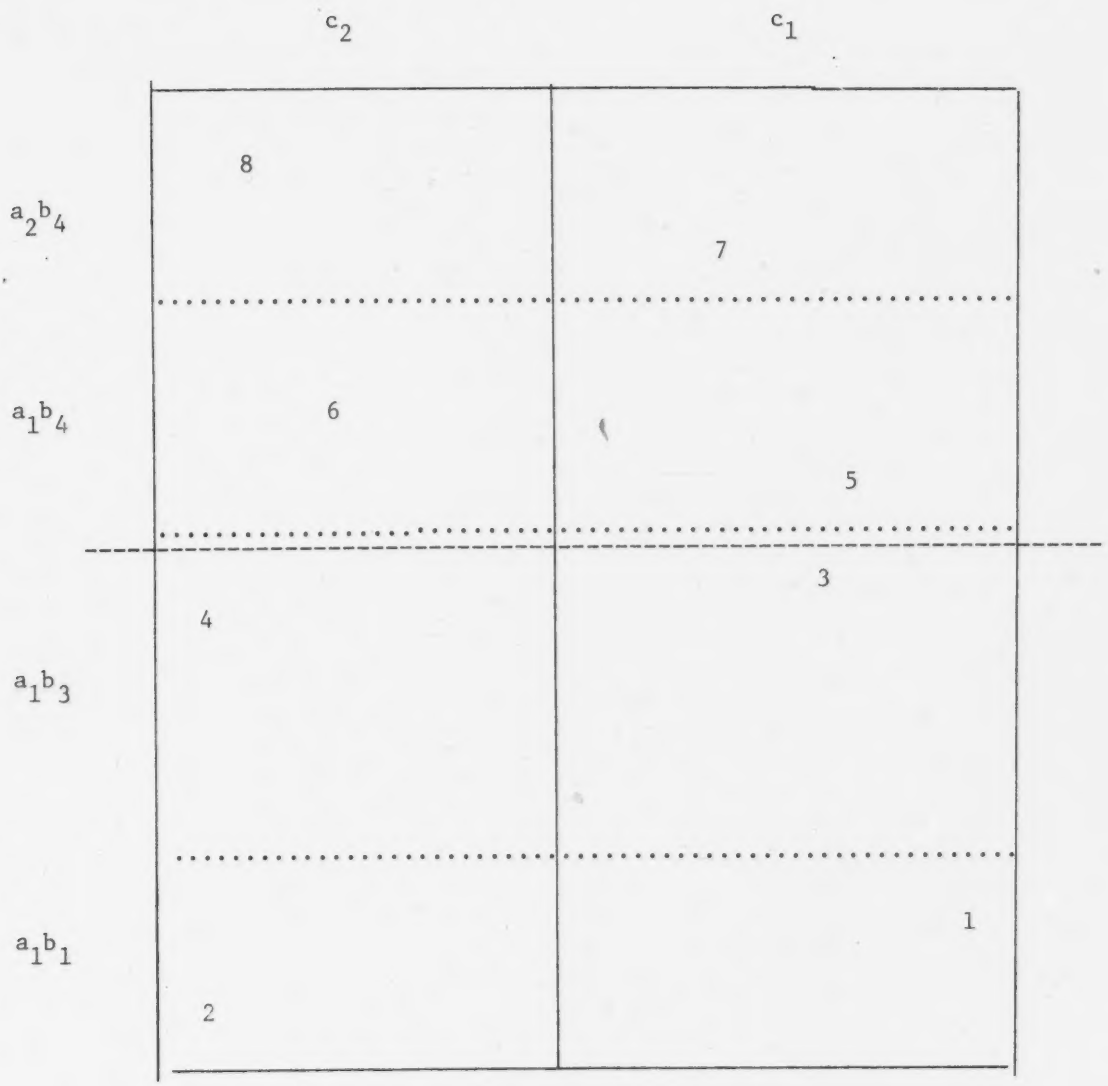

FIGURE I - Space Diagram of the Eight Frequent Structuples

(A copy from the computer output)

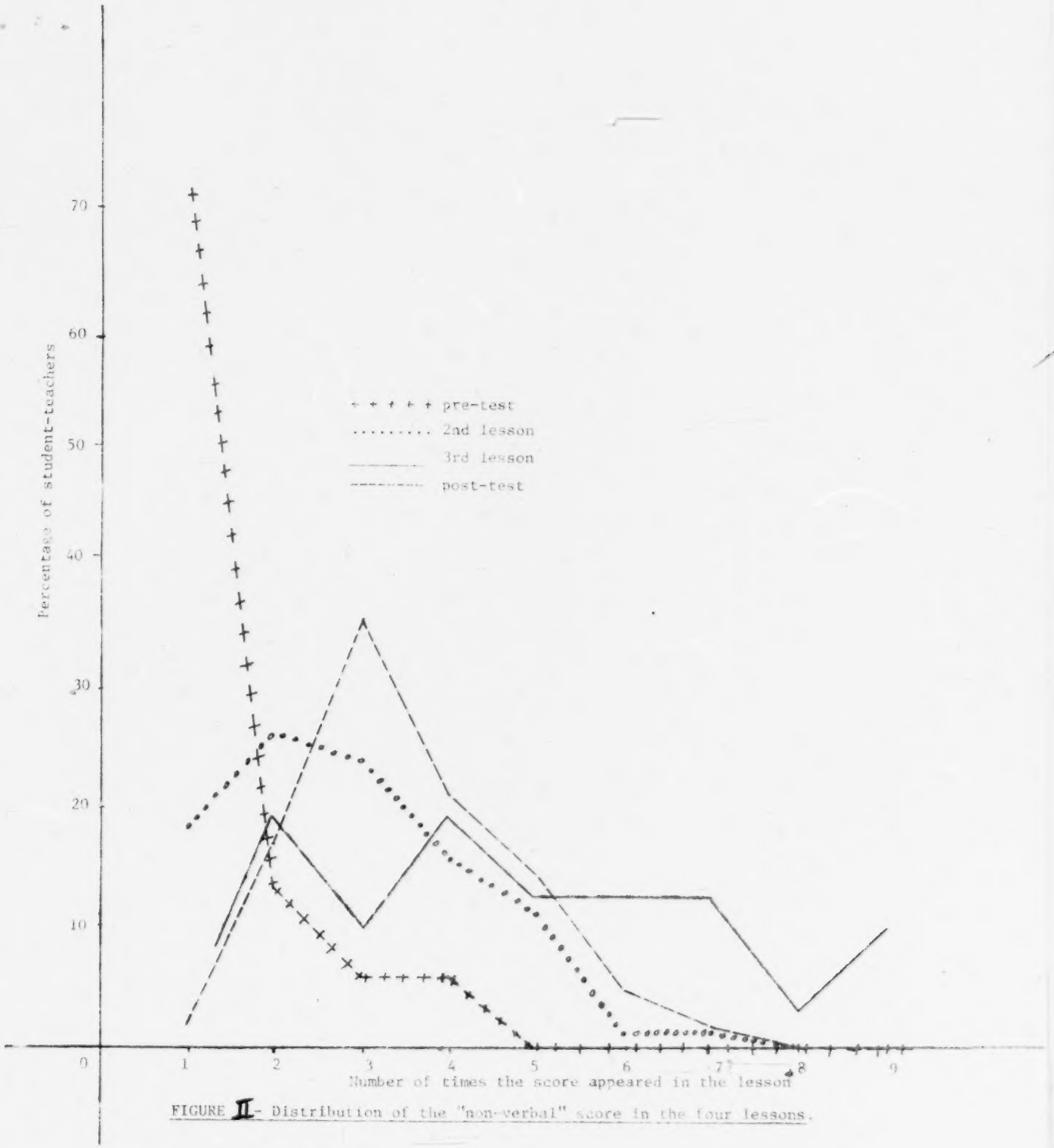

FIGURE II- Distribution of the "non-verbal" score in the four lessons.

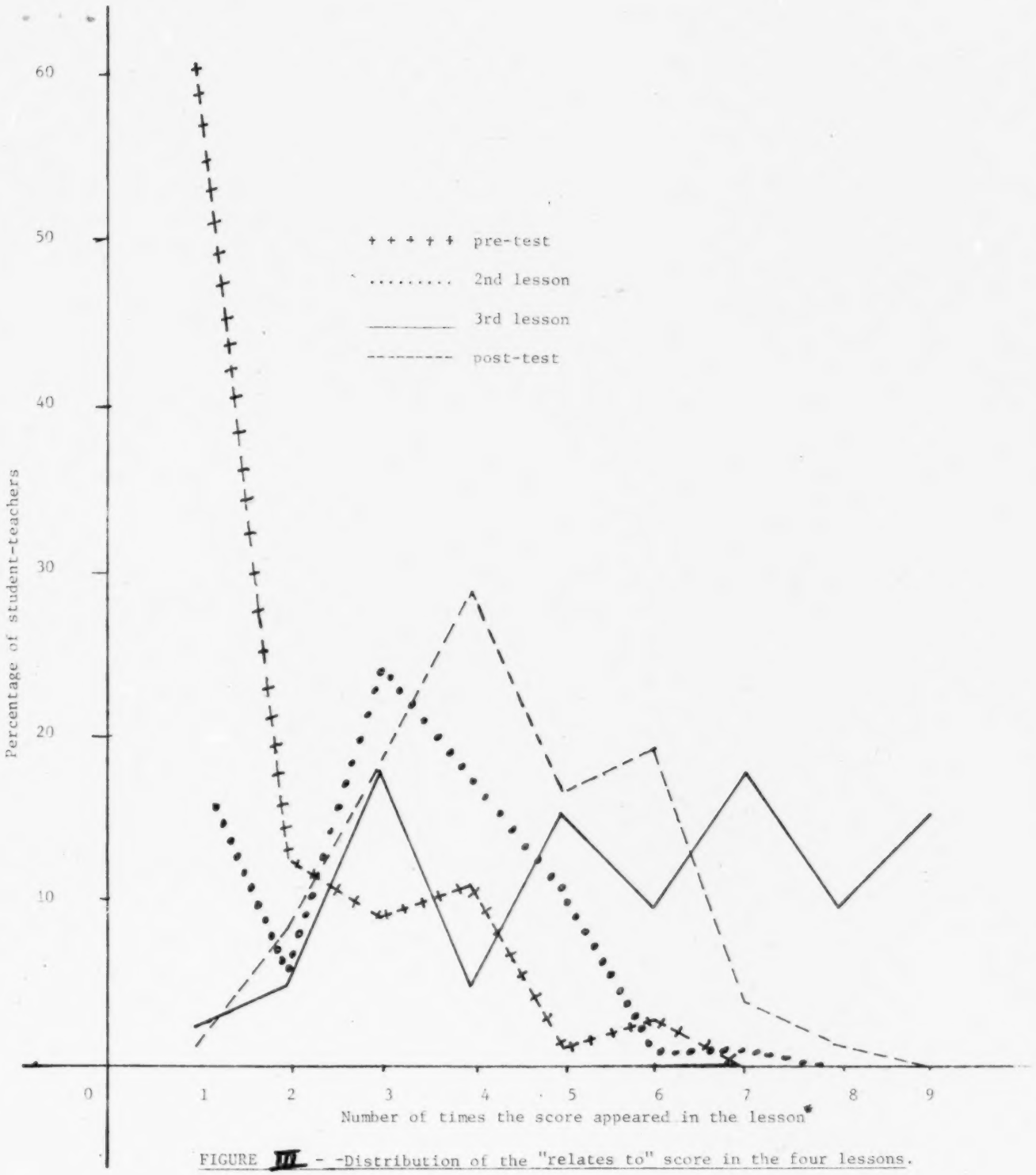

FIGURE III - -Distribution of the "relates to" score in the four lessons.

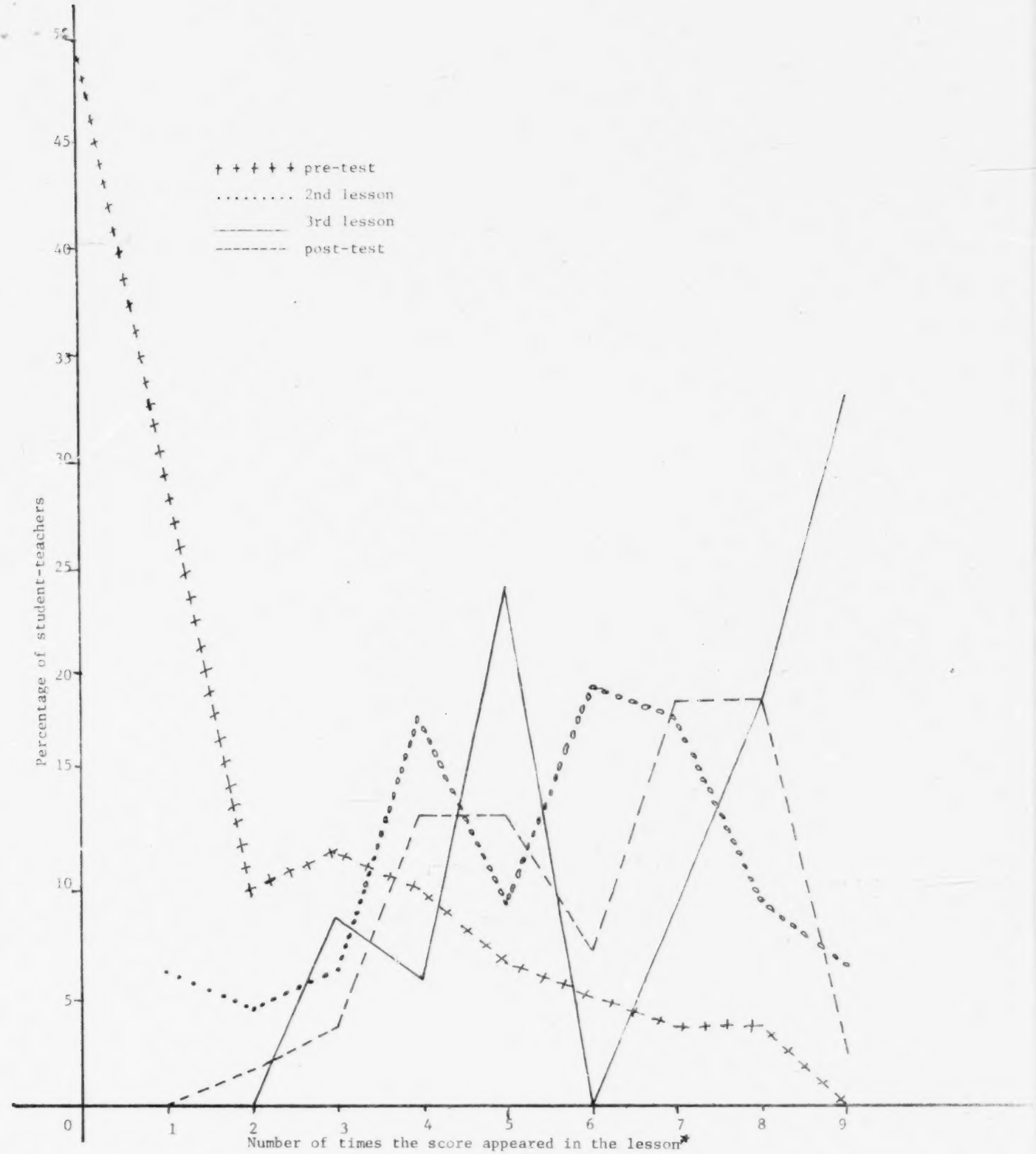

FIGURE IV - Distribution of the "not-lecturing" score in the four lessons

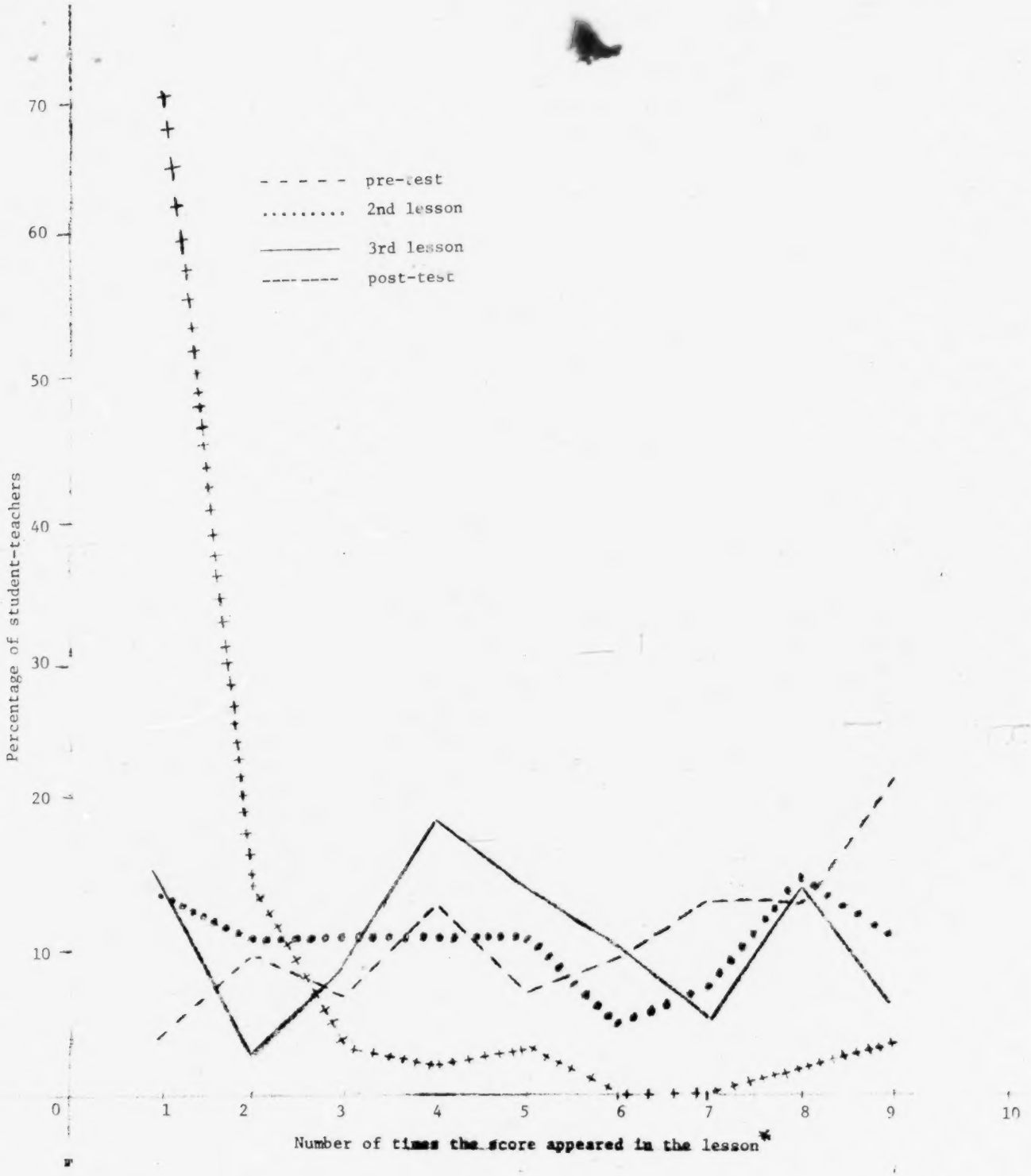

FIGURE V - Distribution of the "analytical thinking" score in the four lessons.

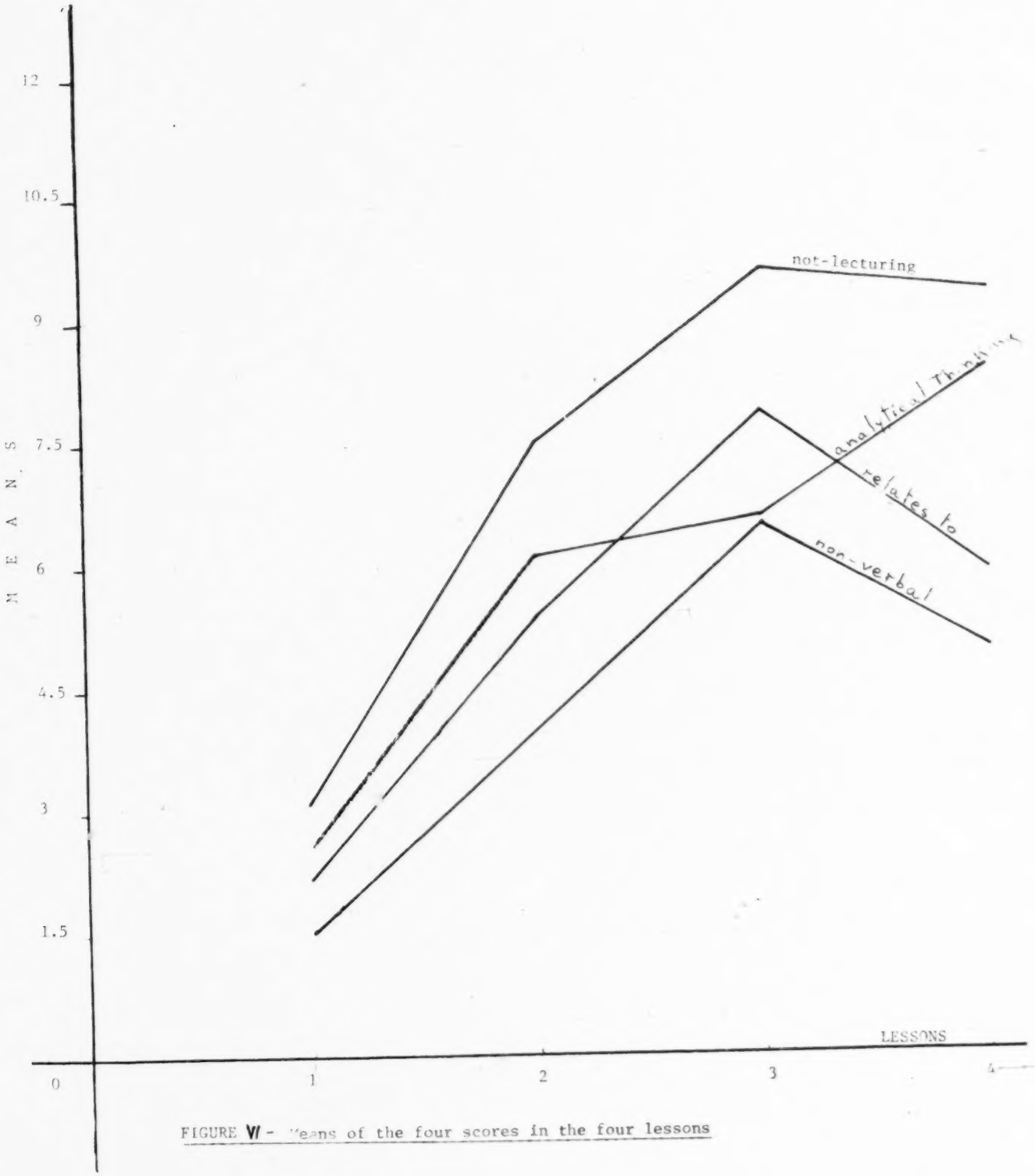

FIGURE VI - Means of the four scores in the four lessons

* Note to Figures II, III, IV and V

The actual values of the number of times the score appeared in the lesson are as follows:

1 = 0 - 15
2 = 16 - 25
3 = 26 - 35
4 = 36 - 45
5 = 46 - 55
6 = 56 - 65
7 = 66 - 75
8 = 76 - 85
9 = 86 - 100